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THE RELATIONSHIP OF BATHING WATER QUALITY TO HEALTH

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*THE RELATIONSHIP OF BATHING WATER QUALITY TO HEALTH

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Historical Background

The question is frequently raised as to what is the real significance, if any, of the relationship between bathing water quality and illness occurrences among bathers. In this discussion, I will confine my remarks to bathing water quality as reflected by its microbiological content and omit discussion of the effects of toxic concentrations of chemicals or special physical factors which in specific areas may play an essential role in the occurrence of illness in a bathing group.

Scientific proof of the transmission of disease from bathing water to bather is extremely meager. However, many reports have been made by competent authorities which cite numerous incidents in which epidemiological evidence has incriminated particular bathing areas as the source of disease cases and epidemics. In 1892, Jaeger[1] reported in detail on some ten cases of enteric infection, in seven of which exposure through bathing in Danube River water or its tributaries was determined to be the only probable cause. In his report Jaeger notes that a highly virulent proteus organism was discharged into the water as the result of an upstream fowl epidemic and that its presence was demonstrated in the water. Jaeger also cites reports of his contemporaries attributing other enteric infections to river water bathing.

A few specific diseases which have been reported as contracted from bathing should be mentioned. First, Leptospirosis - Stallybrass[2] refers to the occurrence of this disease among troops in the wet trenches in World War I, among bathers in the River Vesle and in a canal at Rheims, as reported by Railliet[3] in 1924, and to swimming in dirty ditches and a canal in Holland, as reported by Schuffner and Ruys[4] in 1925. He also refers to many cases of this disease occurring among Japanese paddy field workers. Havens et al,[5] reported on seven cases of this disease contracted through swimming in a public pool formed by a dam in a creek near Philadelphia in 1939. One death occured. More recently, at a panel discussion on Leptospirosis at the 1952 annual meeting of the American Public Health Association, cases were cited which were attributed to bathing waters and to swimming in a barge canal. However, there was no persistence of contamination observed in these waters.

Next, typhoid fever - In 1909, Reece[6] referred to some thirty cases of typhoid fever occurring at the Walmer Naval Station which were attributed to swimming in a pool which received sewage polluted salt water. An APHA Committee Report of 1922[7] refers to an outbreak of this disease at a boy's

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16. Abstracts: Reported illnesses attributed to bathing in natural and artificial waters are described in outlines of three studies conducted by the Public Health Service. Data were gathered as to swimming and illness experience by age, sex, and other groupings. They show that higher illness incidence may be expected in the swimming group than in the non-swimming group regardless of water quality. Eye, ear, and respiratory ailments represent more than half of the overall illness incidence, gastrointestinal up to one-fifth, and skin irritations and other illnesses the balance. It is concluded that some water quality requirements could be relaxed without detrimental effect.

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camp, and again Vaughan[8] in 1921, reports on typhoid fever cases attributed to swimming at sewage polluted municipal beaches in Detroit. Most careful studies of the occurrences of 61 cases of typhoid fever in New Haven, Connecticut, in 1921 and 1922, by Ciampolini and Hitchcock[9], excluded the likelihood of drinking water, foods, or milk as common sources of the infection and pointed to the swimming in sewage polluted harbors, together with personal contact with sick cases and typhoid carriers, as the probable sources of infection. One of the striking findings in this study was that 80% of the cases occurred among children under twenty years of age, two thirds of whom were boys. Past quarterly reports of the New York City Health Department frequently have attributed cases of typhoid fever to bathing in adjacent polluted waters. One such quarterly report[10] lists 51 cases and in the discussion of the subject notes "from all of the data on hand, it is very probable that most of the increase (in typhoid fever) may be charged to bathing in polluted harbor waters condemned by the Department of Health." In a report of a pollution survey of Santa Monica Bay beaches[11], prepared by the California State Board of Public Health in 1942, a case of paratyphoid among the life guards was quite definitely linked to bathing in the polluted waters in this area.

Cholera also has been attributed to bathing in polluted waters. In particular, the Ganges River[2] has been accused as the source of thousands of cases of this disease on the Pilgrimages. It should be pointed out, however, that in all likelihood, this may be due more to drinking the sacred river water than to bathing in it. The parasitic infection, schistosome dermatitis, or swimmers itch, has been a troublesome problem in fresh water lakes in the northern midwestern states as reported by Miller.[12]

There have been numerous reports of the occurrence of eye, ear, nose and throat ailments which have been specifically attributed to bathing. In the 1922 report of the APHA Committee on Bathing Beaches[7], the result of circularization of some 2000 physicians to determine cases and opinions is reported. It should be noted that a major portion of those replying considered the following diseases to be of importance from the standpoint of their contraction from bathing in waters:

Eye infections: particularly pink eye and conjunctivitis
Ear infections: particularly otitis Media
Nasal infections: particularly colds and sinus infections
Skin infections: particularly gonococcus infection of the eyes
Gastro-intestinal diseases: particularly typhoid, paratyphoid and dysentery

In contrast to this, a later circularization of State health departments by the same committee in 1939 revealed relatively few authenticated cases of illness attributable solely to bathing waters.

In 1948 Gallagher[13] reported on his observations on the use of a swimming pool and its relation to illness, covering a seven-year period at Phillips Academy, Andover, Mass. Some of the more significant observations in his report were: (1) Although the regular swimmers represented possibly a more select physical group, more hospitalized illness for respiratory diseases occurred among them than among non-swimmers. (2) The possibility of the spread of measles and mumps seems to be much greater in the presence of an initial case within a swimming group than its presence within a group not using the swimming pool. (3) When careful control is exercised and when normal conditions exist in the operation of a swimming pool, there is no reason to expect a high incidence of respiratory infections among swimmers.

Again, it should be reiterated that scientific proof of the direct relationship between bathing water quality and illness occurrences among bathers is not available. But certainly the preponderance of evidence is such as to suggest that such relationship does exist. In many of the outbreaks reported above, the water quality was relatively poor and no attempt was made to define limiting marginal water quality relationships.

Studies of Bathing Water Quality and Health

In an attempt to determine what, if any, relationship existed between bathing water quality and illness occurrences among bathers, the Environmental Health Center has conducted a series of field studies with selected population groups in cooperation with State and local agencies.[14, 15, 16] It was felt that epidemiological information of this type would be particularly useful to health administrators responsible for determining the permissible water quality levels at which bathing would be permitted within their respective jurisdictions. The specific objectives of these studies were: 1) To determine the frequency of swimming which might be expected from the population groups selected; 2) To determine the relative increase in illness which might occur from swimming in even the cleanest waters; and 3) To determine the differences in illness incidence due to swimming in waters of different bacterial quality, if such differences exist.

In order to obtain geographical, climatic, and natural water quality differences, the studies were undertaken in three different areas including: Lake Michigan at two selected beaches in the City of Chicago; the Ohio River at a bar located in Dayton, Kentucky, opposite Cincinnati, with a nearby recirculating swimming pool used as a second swimming area for comparative purposes; and the tidal waters of Long Island Sound at municipal beaches located in New Rochelle and Mamaroneck, New York.

The conduct of studies of this type is an excellent example of the necessity for team work among various public health professional specialists, including epidemiologists, statisticians, engineers, bacteriologists and educators, working in close cooperation with public health administrators and the public. In each of the studies, the general method of approach was the same, although techniques were improved with each successive undertaking.

First, two bathing areas were selected on the basis of the following criteria:

(1) The beach waters had substantial differences in bacterial quality based upon historical records of water quality available. Unfortunately, subsequent laboratory examinations did not always show such differences.

(2) Sanitary surveys indicated that the water quality was not subject to rapid fluctuation, although changes over a period of days were desirable.

(3) The areas were in close proximity to resident population groups of 1500 or more families. These groups were of similar socio economic status and, insofar as possible, used the same drinking water and food supplies.

(4) The areas were used frequently for swimming by residents of the adjacent areas. Non-swimmers of the same age and sex and living in the same areas formed one of the control groups used. (Non-swimmers were persons who did no swimming during the course of the study).

Second, after selection of the study areas, an informational campaign was directed at the community as a whole and specifically at the particular groups living in the study areas. In addition to the use of regular informational media such as newspapers, radio, and television, the objectives of the study were brought to the attention of the local medical society, parent-teacher associations and other civic groups.

Third, following this informational campaign, project workers visited the individual households in the selected areas. Families who agreed to cooperate in the study were furnished with a calendar report form on which to record daily illness and swimming experience for each member of the family during the study period. Basic family data was obtained on names, age, and sex, and information as to chronic ailments. The daily illnesses listed for record on the basis of a familial diagnosis included eye, ear, nose, and throat ailments, gastro-intestinal disturbances, and skin irritations. Follow up visits to these households were made two or three times during the study. Incidentally, it was most encouraging to note the interest of the participating families in the studies. After having the calendar forms in their possession for two months, more than 80% of the families returned them in useable form, although there was evidence that in some instances they were not kept up on a day to day basis.

Fourth, throughout the period of study a regular sampling program of waters at the respective bathing areas was undertaken and bacterial examinations were made of the collected samples. The densities of both the coliform and the enterococcus groups of organisms were determined. Along with

this, information was obtained on rainfall, temperature, wind, flow conditions, sanitary conditions, bathing load, and other physical factors.

Fifth, following completion of the field aspects and collection of the calendar forms, a detailed statistical analysis of swimming and illness experience and the occurrence of illness as related to water quality conditions was made and reports prepared for each individual study.

It should be noted that in these studies consideration was not given to the less tangible, but nonetheless, beneficial aspects of outdoor swimming, such as fresh air, mental relaxation, moderate amounts of sunshine, physical exercise, etc.

Epidemiological Findings

The results of the three studies are summarized in the accompanying tables[17] and figures. Table #1 gives the basic data for each of the three studies. It shows that the bacterial pollution loads at the bathing areas in Lake Michigan were relatively low with medians of 91 and 190 coliform organisms per 100 ml respectively, and with maxima* of 3500 and 24,000. The Ohio River bathing area had substantial bacterial pollution with a median of 2700 per 100 ml and with a maximum of 160,000.* The tidal waters of Long Island Sound showed moderate pollution, with respective medians at the two beaches of 610 and 253 per 100 ml but they were subject to extreme fluctuations, rising as high as 460,000 during storm periods.

It will be noted that increasing numbers of persons were used in each successive study. The period of observation averaged 57 days in Chicago, 32 days in Dayton-Bellevue, Kentucky, and 60 days in New Rochelle and Mamaroneck, New York.

Table #2 shows the percentage of total person-days of reported swimming for males and females with and without reported chronic conditions, and subdivided into age groups. From this table, it is apparent that there was no appreciable difference in the amount of swimming done by males and females of all ages at the Lake Michigan beaches or in the Tacoma Park Pool. The males did show a higher tendency to swim in the Ohio River and the females to use the Long Island Sound beaches. Surprisingly, the amount of swimming done by persons reporting one or more chronic conditions approached, and in some cases, exceeded that done by individuals reporting no chronic conditions. However, most of the chronic conditions noted were of a minor nature, allergies being particularly prominent. The swimming experience is presented graphically for each study area and age group in Figure 1.

Overall, the "under 10 year old" age group did 20 to 40 per cent and the "under 20 year old" age group, 60 to 75 per cent of the total swimming. As would be expected, the age groups over 44 years of age did the least amount of swimming. In general, the total amount of swimming at the individual bathing areas varied in accordance with accessibility of the bathing

*Maximum values not shown in the table.

areas from the residential areas, size of the population group, availability of other attractive swimming areas, cost, attractiveness of the bathing area, and weather.

Table #3 shows the recorded illnesses per 1000 person-days for individual groups within each study area. It also shows the illness incidence by type of ailment, including eye, ear, nose and throat ailments, gastro-intestinal disturbances, and skin irritations. In each of the studies the incidence of gastro-intestinal disturbances reported for the entire group (swimmers plus non-swimmers) was less than 20% of the incidence for all types of illnesses. The incidence of eye, ear, nose and throat ailments was somewhat more than half of the total.

With respect to specific groups it should be noted that Long Island Sound non-swimmers had the lowest illness incidence rate. (3.3 per 1000 person-days , not shown in the table). Also, it is significant to note that the Dayton-Bellevue pool swimmers had an incidence for all types of illnesses of 13.8 per 1000 person-days, the highest for any comparable group. Eye, ear, nose and throat ailments comprised 68% of this incidence; gastro-intestinal disturbances 15%.

This relatively high incidence of respiratory illness among pool swimmers can be explained in two ways. First, the availability of diving facilities at the pool, but not at the river beach, could account for greater penetration of the respiratory tract. Second, the closer proximity of bathers to one another and the smaller quantity of water available for dilution per bather could be expected to aid in the transmission of respiratory infections.

On the other hand, river swimmers in the same population group under study, with a lower total illness incidence rate had a gastro-intestinal illness rate of 2.4 illnesses per 1000 person-days of experience which is the highest rate observed for any comparable group. Also, in Figure #2 where the gastro-intestinal illness incidence is shown as a percentage of the illness incidence for all types of ailments, the Ohio River swimmers stand out as the swimming group with the highest percentage of gastro-intestinal illness, exceeding the non-swimming control group. In analyzing this observation, illness rates for all swimming groups combined, but specific for age and amount of swimming, were used to compute "expected" illnesses and to compare them with "observed" illnesses. This comparison showed that river swimmers had 32 per cent more gastro-intestinal illness than might be expected on the basis of all groups combined.

Consistent as this may be with the hypothesis of more gastro-intestinal illness for persons swimming in water with higher coliform densities, in this case 2700 per 100 ml, the result must be treated with great caution because of the small number of cases involved. It roughly corresponds to a probability of five per cent that such a result could occur as a result of chance. In any event, the observation cannot be explained away by a tendency of river swimmers to be less healthy.

An approximation of the relative increase in illness incidence from swimming in relatively clean waters is shown in Table #4. The ratio of illness incidence is given for the Lake Michigan study groups doing different amounts of swimming over the entire period, as compared with that for non-swimmers. In developing this table, age-specific illness rates were applied to the various age groups in each category. The rates for all ages were then adjusted to take into account differences in age distribution of the populations in the sub-groups. In this comparison, no significant correlation was observed which could be attributed to swimming in natural waters of different quality at the areas studied. However, in practically every instance, the illness incidence among swimmers was higher than that among the non-swimmers. This was expected inasmuch as water is an abnormal habitat for man regardless of its bacterial quality. The illness incidence generally increased for progressively higher swimming frequencies, but the groups doing the most swimming tended to show less rise in illness incidence and in several instances a marked decrease. This may well be explained by the selective physical characteristics of individuals in the group which did the most swimming, since illness occurrence would prevent their inclusion in such a group. Direct comparison of illness incidence between swimmers and non-swimmers by age group is shown for the two Lake Michigan areas in Figure #3.

In the attempt to determine what differences in illness incidence might be expected from swimming in waters containing various degress of bacterial pollution, an inspection of over-all illness incidence rates for the swimming groups was not fruitful and more sensitive and selective analysis was indicated. Consequently, days of relatively "high" and relatively "low" coliform densities were selected and analysis was made of the illness occurring among the individuals who swam on these days.

Table #5 shows the results of such an anlysis in the Great Lakes study. The observed three-day incidence rate of 12.2 per 100 South Beach swimmers for illnesses occurring within a week subsequent to swimming is significant. It indicates that swimming in these waters containing a mean coliform density of 2300 per 100 ml may cause more illness than swimming in waters with the lower average densities shown. This observation, based upon a significance test against the hypothesis that "high" pollution causes an increase in illness incidence, is one which could occur as a result of chance, but once in one hundred trials. However, this evidence is not at all conclusive. There were only three days on each side of the comparison and this did not permit a complete analysis of the effect that weather might have had on the result. When the weather is hot many more people go swimming, some being people who would only swim on very hot days. It is quite possible that such people have a characteristically higher or lower rate of illness than those who swim more regularly.

Furthermore, the other two studies did not support similar conclusions. In the Ohio River study the number of swimmers on specific "high" and "low" pollution days was too small for comparative study. In the Long Island Sound study larger swimming groups were available for comparative analysis

of illness but no correlation could be made with bathing water quality. The effect that "salt water" may have had on this result is of course open to speculation.

Summary and Conclusions

A brief account of reported illnesses attributed to bathing in natural and artificial waters has been presented. Three studies conducted by the Public Health Service in order to secure epidemiological and correlated bathing water quality data have been outlined.

These studies have furnished information as to swimming and illness experience by age, sex, and other groupings. They have demonstrated that higher illness incidence may be expected in the swimming group than in the non-swimming group regardless of water quality. They have shown that in studies of this type, eye, ear, and respiratory ailments will represent more than half of the overall illness incidence, gastro-intestinal disturbances up to one-fifth, and skin irritations and other illnesses the balance.

Two instances of statistically significant correlation between illness incidence and bathing water quality were noted, but these results should be used with caution for the reasons previously given.

Despite the difficulties encountered in these studies in which nature rather than man controlled most of the variables, it appears from the observed results that some of the most rigid natural bathing water quality requirements could be relaxed without detrimental effect to the health of the bathers. This always has been, and will continue to be, a matter of judgment. It is hoped that these results will be of assistance to the administrators responsible for making these decisions.

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Table 1
BASIC DATA SUMMARY

Study	Group	Median Water Quality at Study Bathing Area - Coliform MPN per 100 ml	Number of Persons in Study	Number of Person-Days of Usable Record	Percentage of Person-Days of Total Swimming	Number of Illnesses of all Types Recorde per 1000 person-days
Great Lakes	Chicago-North Chicago-South	91 190	5124	154,453 138,158	10.3 10.7	7.1 8.3
Inland River and Pool	Dayton and Bellevue	2700[1]	7520	242,094	4.5	8.8
Tidal Water	New Rochelle Mamaroneck	610 253	9520	269,629 300,503	7.3 8.0	5.3 6.2

[1] Ohio River at Dayton Bar. Pool water quality less than 3.0.

Table 2

PERCENTAGE OF TOTAL PERSON-DAYS WITH REPORTED SWIMMING AT DESIGNATED STUDY AREAS BY AGE GROUPS

Age Group	Great Lakes				Inland River and Pool [1]				Tidal Water [2]			
	North Beach		South Beach						New Rochelle		Mamaroneck	
	Males	Females	Males	Female	River		Pool		Male	Female	Male	Female
					M	F	M	F				
Persons with no chronic conditions												
Under 5 yrs.	15.8	17.0	13.3	12.7	0.8	0.8	0.5	0.4	5.5	6.4	6.2	8.3
5-9 yrs.	25.6	25.2	23.2	22.9	1.5	2.1	2.2	2.0	8.5	8.6	14.0	13.5
10-19 yrs.	28.6	27.7	32.9	25.8	3.9	2.0	4.6	3.9	10.0	11.2	11.4	15.7
20-44 yrs.	6.4	9.1	8.1	9.0	2.1	1.0	0.6	0.9	2.3	3.6	2.9	5.3
45-64 yrs.	4.3	3.6	3.3	1.6	0.8	0.3	0.1	0.2	2.6	1.9	1.2	2.8
Over 64 yrs.	0.4*	0.0*	0.7	0.1*	0.2*	-	-	-	0.8	2.2	0.9	0.8
Age unknown	1.7	2.2	8.1	8.9	5.4	0.6*	6.2	2..	3.6	4.0	1.6*	9.6
All ages	10.5	10.9	11.1	10.5	2.0	1.2	1.5	1.5	4.5	5.4	5.3	7.4
Persons with one or more chronic conditions												
Under 5 yrs.	15.2	21.8	2.1	30.8	0.4*	0.2*	0.2*	0.5*	2.3	3.0*	8.0	6.6
5-9 yrs.	19.1	9.0	31.9	21.2	0.3*	0.8*	2.4	1.7*	10.8	5.6	15.3	17.9
10-19 yrs.	23.5	23.0	34.0	26.8	3.1	1.0*	4.0	7.1	11.1	6.7	12.9	26.0
20-44 yrs.	6.0	7.6	6.4	8.3	1.5	1.1	1.3	0.7	1.6	4.1	3.3	5.3
45-64 yrs.	1.9	1.6	3.7	4.1	1.5	-	0.5*	0.1*	0.6*	1.2	1.7	6.4
Over 64 yrs.	-	-	0.4*	-	-	-	-	-	0.7*	1.0*	-	-
Age unknown	16.3	5.3	-	-	...	...	...	...	...	2.2*	-	...
All ages	8.7	8.0	9.9	9.7	1.6	0.8	1.5	1.2	3.7	3.6	5.6	7.7

1) Approximately an equal amount of additional swimming was done by the study group in non-study areas.

2) Approximately 50% additional swimming was done by the study group in non-study areas.

\- Numerator is zero

... Denominator is zero

* Based on less than 10 in the numerator

0.0 Less than 0.05

Table 3

RECORDED ILLNESSES PER 1000 PERSON-DAYS

Study	Group	Types of Illness				
		All Types	Gastro-Intestinal	Other Illnesses Reported		
				Nose & Throat	Skin	Eye, Ear & Other
Great Lakes	North Beach					
	Under 10 yrs.	13.1	2.3	7.0	1.4	2.4
	10 yrs. & over	5.9	1.2	3.2	0.5	0.9
	Entire group All ages	7.1	1.4	3.9	0.7	1.2
	South Beach					
	Under 10 yrs.	12.7	2.0	6.4	1.4	2.0
	10 yrs. & over	7.1	1.4	3.8	0.5	1.5
	Entire group All ages	8.3	1.5	4.3	0.7	1.8
Inland River and Pool				Eye, Ear, Nose & Throat		Other
	Entire group All ages	8.8	1.7	5.3		1.8
	*Non-Swimmers	7.4	1.5	4.4		1.5
	*Pool Swimmers	13.8	2.1	9.4		2.3
	*River Swimmers	10.1	2.4	5.4		2.3
	*Total Pool & River Swimmers	12.1	2.3	7.5		2.3
Tidal Water				Eye, Ear, Nose & Throat		Other
	New Rochelle					
	Under 10 yrs.	8.0	1.1	4.1		2.8
	10 yrs. & Over	4.3	0.6	2.6		1.1
	Entire group All ages	5.3	0.8	3.0		1.5
	Mamaroneck					
	Under 10 yrs.	10.7	1.3	6.2		3.2
	10 yrs. & over	5.0	0.7	3.0		1.3
	Entire group All ages	6.2	0.9	3.7		1.7

*Under 65 years of age

Table 4

RATIO OF ILLNESS INCIDENCE OF SWIMMERS TO NON-SWIMMERS
BY ILLNESS TYPE, SWIMMING FREQUENCY, WATER QUALITY, AND AREA
Great Lakes Study - Chicago, Illinois

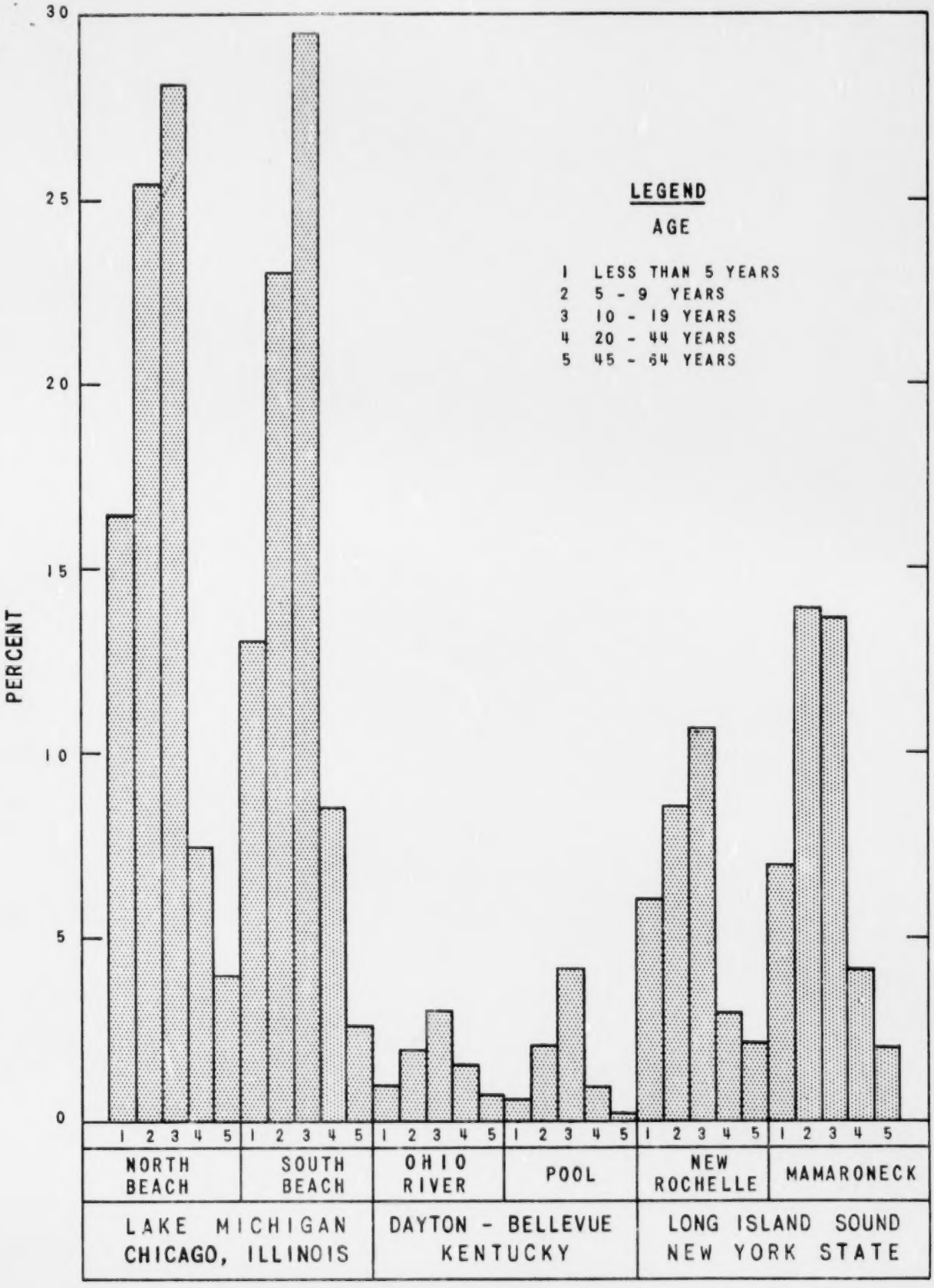
Group	Median Water Quality Coliform Organisms MPN per 100 ml	Swimming Experience - Days			
		0	1 to 9	10 to 24	Over 24
			All Types of Illness		
North Beach	91	1.0	2.2	2.3	2.6
South Beach	190	1.0	1.4	1.5	1.2
			Nose and Throat Ailments		
North Beach	91	1.0	2.2	2.5	2.4
South Beach	190	1.0	1.4	1.3	1.2
			Gastro-Intestinal Disturbances		
North Beach	91	1.0	1.7	1.8	2.5
South Beach	190	1.0	0.9	1.0	0.7
			Other Types of Illness		
North Beach	91	1.0	2.4	2.4	3.1
South Beach	190	1.0	2.2	2.6	2.0

Table 5

ILLNESS INCIDENCE RATES FOLLOWING SWIMMING ON SELECTED DAYS
OF SIGNIFICANTLY HIGH AND LOW COLIFORM DENSITY DURING GREAT LAKES STUDY

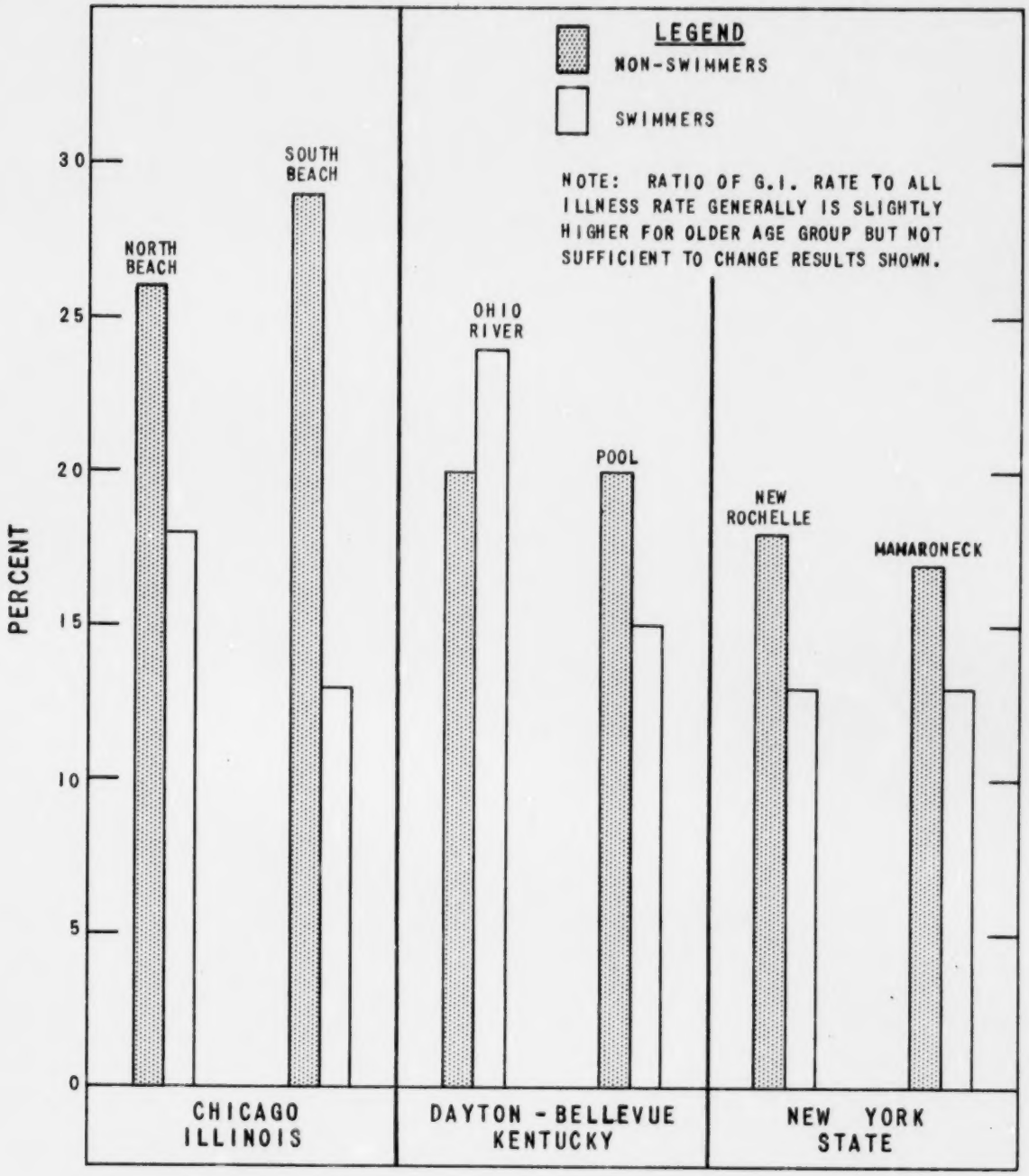
Groups	Number of Selected Days	Mean Coliform Density on Selected Days MPN per 100 ml [1]	Number of Persons Swimming at Neighborhood Beach	Number of Swimmers Reporting Illness In Subsequent Week	3-day Illness Incidence Rate per 100 Swimmers
North Beach Swimmers	3 "high"	730	558	55	9.9
North Beach Swimmers	3 "low"	31	832	72	8.7
South Beach Swimmers	3 "high"	2300	566	69	12.2
South Beach Swimmers	3 "low"	43	932	79	8.5

[1] Logarithmic average of results of all bacterial examinations.



PERCENT PERSON — DAYS OF REPORTED SWIMMING

FIGURE 1



GASTRO-INTESTINAL ILLNESS AS A PERCENT OF OVERALL ILLNESS

FIGURE 2

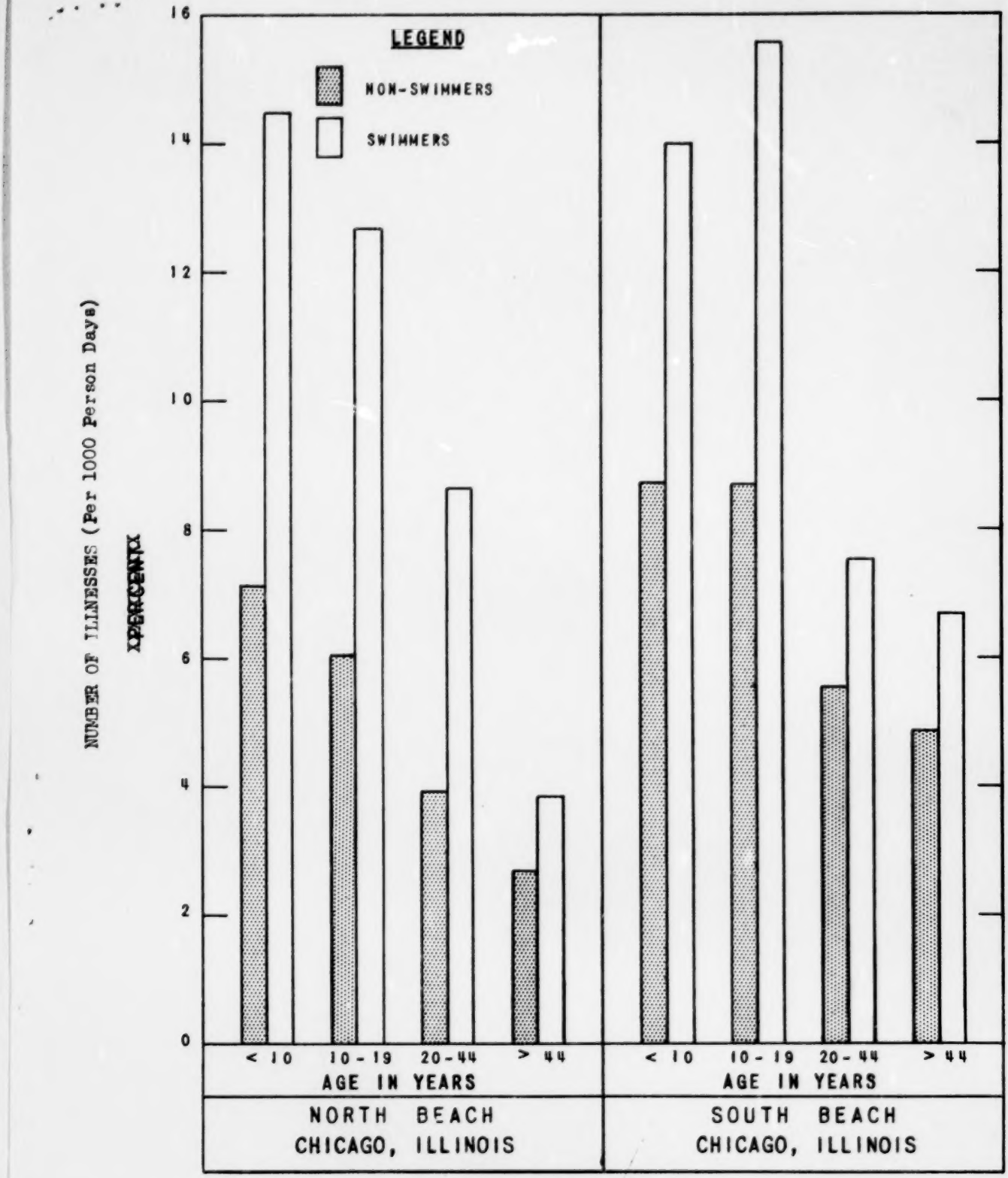

LEGEND
NON-SWIMMERS
SWIMMERS
NUMBER OF ILLNESSES (Per 1000 Person Days)
16
14
12
10
8
6
4
2
0
< 10
10 - 19
20 - 44
> 44
AGE IN YEARS
NORTH BEACH
CHICAGO, ILLINOIS
SOUTH BEACH
CHICAGO, ILLINOIS
NUMBER OF ILLNESSES PER 1,000 PERSON DAYS

FIGURE 3